

## WHAT IS CLAIMED IS:

1. A camera calibrating apparatus to be operative in combination with an imaging device which includes a housing unit and an optical section supported by said housing unit to obtain image information thorough said optical section, and adapted to calibrate position information of said optical section, comprising:

first housing position information storing means for storing first housing position information indicative of a position of said housing unit in the first coordination system;

second housing position information storing means for storing second housing position information indicative of a position of said housing unit in the second coordination system;

first optical position information producing means for producing first optical position information indicative of a position of said optical section in said first coordination system on the basis of said image information obtained by said imaging device in said first coordination system;

first optical position information storing means for storing said first optical position information produced by said first optical position information producing means;

second optical position information producing means for producing second optical position information indicative of a position of said optical section to said second coordination system from said second housing position information stored by said second housing position information storing means on the basis of said first housing position information stored by said first housing position information storing means and said first optical position information stored by said first optical position information storing means;

second optical position information storing means for storing said second optical position information produced by said second optical position information producing means; and

calibrating means for calibrating said second optical position information stored by said second optical position information storing means on the basis of said image information obtained by said imaging device in said second coordination system.

2. A camera calibrating apparatus to be operative in combination with an imaging device which includes a housing unit and an optical section supported by said housing unit to obtain image information thorough said optical section, and adapted to calibrate optical position information indicative of a position of said optical section, comprising:

optical position information storing means for storing optical position information indicative of a position of said optical section to a predetermined coordinate system; and

calibrating means for calibrating said optical position information stored by said

optical position information storing means on the basis of said image information obtained by said imaging device on said predetermined coordinate system.

3. A camera calibrating apparatus to be operative in combination with an imaging device which includes a housing unit and an optical section supported by said housing unit to obtain image information thorough said optical section, and adapted to calibrate optical position information indicative of a position of said optical section, comprising:

first housing position information storing means for storing first housing position information indicative of a position of said housing unit in the first coordination system in which a revising marker is located;

second housing position information storing means for storing second housing position information indicative of a position of said housing unit in the second coordination system in which a calibrating marker is located;

first optical position information producing means for producing first optical position information indicative of a position of said optical section in said first coordination system on the basis of said image information of said revising marker obtained by said imaging device;

first optical position information storing means for storing said first optical position information produced by said first optical position information producing means;

second optical position information producing means for producing second optical position information indicative of a position of said optical section to said second coordination system from said second housing position information stored by said second housing position information storing means on the basis of said first housing position information stored by said first housing position information storing means and said first optical position information stored by said first optical position information storing means;

estimated location information producing means for producing estimated location information indicative of a position of said calibrating marker to an image coordination system of said imaging device on the basis of said second optical position information produced by said second optical position information producing means;

second optical position information storing means for storing said second optical position information produced by said second optical position information producing means;

estimated location information storing means for storing said estimated location information produced by said estimated location information estimating means; and

calibrating means for calibrating said second optical position information stored by said second optical position information storing means on the basis of said image information of said calibrating marker obtained by said imaging device and said estimated

location information stored by said estimated location information storing means.

4. A camera calibrating apparatus as set forth in claim 3, in which said calibrating means includes:

5 image location information extracting means for extracting an image location information indicative of an image location of said calibrating marker to said image coordination system of said imaging device on the basis of said image information of said calibrating marker obtained by said imaging device;

10 calibration value calculating means for calculating a calibration value of said second optical position information stored by said second optical position information storing means on the basis of said image location information extracted by said image location information extracting means and said estimated location information stored by said estimated location information storing means; and

15 optical position information calibrating means for calibrating said second optical position information stored by said second optical position information storing means on the basis of said calibration value calculated by said calibration value calculating means.

5. A camera calibrating apparatus as set forth in claim 4, in which said calibrating means is adapted to calibrate a deviation of a rotational component  
20 of said second optical position information.

6. A camera calibrating apparatus as set forth in claim 4, in which said image location information extracting means includes:

25 image displaying means for displaying an image of said calibrating marker obtained by said imaging device, and

image location specifying means for specifying said image location of said calibrating marker on said image of said calibrating marker displayed by said image displaying means and to ensure that said image location information is extracted.

30 7. A camera calibrating apparatus as set forth in claim 4, in which said image location information extracting means includes:

estimated area information storing means for storing estimated area information indicative of said calibrating marker to said image coordination system of said imaging device; and

35 image location searching means for searching said image location of said calibrating marker from said image information of said calibrating marker obtained by said imaging device on the basis of said estimated area information stored by said estimated area

information storing means and said estimated location information stored by said estimated location information storing means to ensure that said image location information is extracted.

- 5     8.     A camera calibrating apparatus to be operative in combination with an imaging device which includes a housing unit and an optical section supported by said housing unit to obtain image information thorough said optical section, and adapted to calibrate optical position information inductive of a position of said optical section, comprising:

10     first housing position information storing means for storing first housing position information indicative of a position of said housing unit in the first coordination system in which a revising marker is located;

second housing position information storing means for storing second housing position information indicative of a position of said housing unit in the second coordination system;

15     first optical position information producing means for producing first optical position information indicative of a position of said optical section in said first coordination system on the basis of said image information obtained by said imaging device and indicative of said revising marker;

20     first optical position information storing means for storing said first optical position information produced by said first optical position information producing means;

25     second optical position information producing means for producing second optical position information indicative of a position of said optical section to said second coordination system from said second housing position information stored by said second housing position information storing means on the basis of said first housing position information stored by said first housing position information storing means and said first optical position information stored by said first optical position information storing means;

second optical position information storing means for storing said second optical position information produced by said second optical position information producing means; and

30     calibrating means for calibrating said second optical position information stored by said second optical position information storing means on the basis of a motion vector of said image information obtained by said imaging device in said second coordination system.

- 35     9.     A camera calibrating apparatus as set forth in claim 8, in which said calibrating means includes:

plane-projected image producing means for producing a plane-projected image from said image information obtained by said imaging device in said second coordination

system;

plane-projected image dividing means for dividing said plane-projected image produced by said plane-projected image producing means into a plurality of image segments;

5 motion vector extracting means for extracting said motion vector from said image segments divided by said plane-projected image dividing means;

calibration value calculating means for calculating a calibration value of said second optical position information stored by said second optical position information storing means on the basis of said motion vector extracted by said motion vector extracting means; and

10 optical position information calibrating means for calibrating said second optical position information stored by said second optical position information storing means on the basis of said calibration value calculated by said calibration value calculating means.

15 10. A camera calibrating apparatus as set forth in claim 9, in which a dividing marker located in said second coordination system in a predetermined relationship with said position of said housing unit represented by said second position information stored by said second position information storing means, and in which

20 plane-projected image dividing means is adapted to divide said plane-projected image produced by said plane-projected image producing means into a plurality of image segments on the basis of said image information of said dividing marker obtained by said imaging device.

25 11. A camera calibrating apparatus to be operative in combination with an imaging device which includes a housing unit and an optical section supported by said housing unit to obtain image information thorough said optical section, and adapted to calibrate position information of said optical section, comprising:

30 first housing position information storing means for storing first housing position information indicative of a position of said housing unit in the first coordination system in which a revising marker is located;

second housing position information storing means for storing second housing position information indicative of a position of said housing unit in the second coordination system in which an automotive vehicle is located;

35 first optical position information producing means for producing first optical position information indicative of a position of said optical section in said first coordination system on the basis of said image information of said revising marker obtained by said imaging device;

first optical position information storing means for storing said first optical position information produced by said first optical position information producing means;

second optical position information producing means for producing second optical position information indicative of a position of said optical section to said second coordination system from said second housing position information stored by said second housing position information storing means on the basis of said first housing position information stored by said first housing position information storing means and said first optical position information stored by said first optical position information storing means;

estimated location information producing means for producing estimated location information indicative of a position of said automotive vehicle to an image coordination system of said imaging device on the basis of said second optical position information produced by said second optical position information producing means;

second optical position information storing means for storing said second optical position information produced by said second optical position information producing means;

estimated location information storing means for storing said estimated location information produced by said estimated location information estimating means; and

calibrating means for calibrating said second optical position information stored by said second optical position information storing means on the basis of said image information of said automotive vehicle obtained by said imaging device and said estimated location information stored by said estimated location information storing means.

12. A camera calibrating apparatus as set forth in claim 11, in which said calibrating means includes:

image location information extracting means for extracting an image location information indicative of an image location of said automotive vehicle in said image coordination system of said imaging device on the basis of said image information of said automotive vehicle obtained by said imaging device;

calibration value calculating means for calculating a calibration value of said second optical position information stored by said second optical position information storing means on the basis of said image location information extracted by said image location information extracting means and said estimated location information stored by said estimated location information storing means; and

optical position information calibrating means for calibrating said second optical position information stored by said second optical position information storing means on the basis of said calibration value calculated by said calibration value calculating means.

13. A camera calibrating apparatus as set forth in claim 12, in which  
said calibration value calculating means includes:  
superimposing means for superimposing a profile line of said automotive vehicle  
represented by said image location information on a profile line of said automotive vehicle  
5 represented by said estimated location information;  
extracting means for extracting a plurality of points from said overlapped profile  
lines of said automotive vehicle superimposed by said superimposing means, and  
calculating means for calculating a calibration value of said second optical position  
information by comparing said points of said image location information with said points of  
10 said estimated location information.
14. A camera calibrating apparatus as set forth in any one of claims 1 to 13, in which  
said imaging device is mounted on an automotive vehicle.
15. An imaging system comprises a camera calibrating apparatus as set forth in any one  
of claims 1 to 14.
16. An imaging control system comprises a camera calibrating apparatus as set forth in  
any one of claims 1 to 14.
- 20 17. A camera calibrating method of calibrating optical position information inductive  
of a position of an optical section supported by a housing unit of a camera for obtaining  
image information through said optical section, comprising:  
a first housing position information storing step of storing first housing position  
25 information indicative of a position of said housing unit in the first coordination system;  
a second housing position information storing step of storing second housing  
position information indicative of a position of said housing unit in the second coordination  
system;  
a first optical position information producing step of producing first optical position  
30 information indicative of a position of said optical section in said first coordination system  
on the basis of said image information obtained by said imaging device in said first  
coordination system;  
a first optical position information storing step of storing said first optical position  
information produced in said first optical position information producing step;  
35 a second optical position information producing step of producing second optical  
position information indicative of a position of said optical section to said second  
coordination system from said second housing position information stored in said second

housing position information storing step on the basis of said first housing position information stored in said first housing position information storing step and said first optical position information stored in said first optical position information storing step;

5 a second optical position information storing step of storing said second optical position information produced in said second optical position information producing step; and

a calibrating step of calibrating said second optical position information stored in said second optical position information storing step on the basis of said image information obtained by said imaging device in said second coordination system.

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18. A camera calibrating method of calibrating optical position information inductive of a position of an optical section supported by a housing unit of a camera for obtaining image information through said optical section, comprising:

15 an optical position information storing step of storing optical position information indicative of a position of said optical section to a predetermined coordinate system; and

a calibrating step of calibrating said optical position information stored in said optical position information storing step on the basis of said image information obtained by said imaging device on said predetermined coordinate system.

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19. A camera calibrating method of calibrating optical position information inductive of a position of an optical section supported by a housing unit of a camera for obtaining image information through said optical section, comprising:

25 a first housing position information storing step of storing first housing position information indicative of a position of said housing unit in the first coordination system in which a revising marker is located;

a second housing position information storing step of storing second housing position information indicative of a position of said housing unit in the second coordination system in which a calibrating marker is located;

30 a first optical position information producing step of producing first optical position information indicative of a position of said optical section in said first coordination system on the basis of said image information of said revising marker obtained by said imaging device;

a first optical position information storing step of storing said first optical position information produced in said first optical position information producing step;

35 a second optical position information producing step of producing second optical position information indicative of a position of said optical section to said second coordination system from said second housing position information stored in said second



housing position information storing step on the basis of said first housing position information stored in said first housing position information storing step and said first optical position information stored in said first optical position information storing step;

5 an estimated location information producing step of producing estimated location information indicative of a position of said calibrating marker to an image coordination system of said imaging device on the basis of said second optical position information produced in said second optical position information producing step;

a second optical position information storing step of storing said second optical position information produced in said second optical position information producing step;

10 an estimated location information storing step of storing said estimated location information produced in said estimated location information estimating step; and

a calibrating step of calibrating said second optical position information stored in said second optical position information storing step on the basis of said image information of said calibrating marker obtained by said imaging device and said estimated location information stored in said estimated location information storing step.

20. A camera calibrating method of calibrating optical position information inductive of a position of an optical section supported by a housing unit of a camera for obtaining image information through said optical section, comprising:

20 a first housing position information storing step of storing first housing position information indicative of a position of said housing unit in the first coordination system in which a revising marker is located;

a second housing position information storing step of storing second housing position information indicative of a position of said housing unit in the second coordination system;

25 a first optical position information producing step of producing first optical position information indicative of a position of said optical section in said first coordination system on the basis of said image information obtained by said imaging device and indicative of said revising marker;

30 a first optical position information storing step of storing said first optical position information produced in said first optical position information producing step;

a second optical position information producing step of producing second optical position information indicative of a position of said optical section to said second coordination system from said second housing position information stored in said second housing position information storing step on the basis of said first housing position information stored in said first housing position information storing step and said first optical position information stored in said first optical position information storing step;

a second optical position information storing step of storing said second optical position information produced in said second optical position information producing step; and

5 a calibrating step of calibrating said second optical position information stored in said second optical position information storing step on the basis of a motion vector of said image information obtained by said imaging device in said second coordination system.

21. A camera calibrating method of calibrating optical position information inductive of a position of an optical section supported by a housing unit of a camera for obtaining  
10 image information through said optical section, comprising:

a first housing position information storing step of storing first housing position information indicative of a position of said housing unit in the first coordination system in which a revising marker is located;

15 a second housing position information storing step of storing second housing position information indicative of a position of said housing unit in the second coordination system in which an automotive vehicle is located;

a first optical position information producing step of producing first optical position information indicative of a position of said optical section in said first coordination system on the basis of said image information of said revising marker obtained by said imaging  
20 device;

a first optical position information storing step of storing said first optical position information produced in said first optical position information producing step;

25 a second optical position information producing step of producing second optical position information indicative of a position of said optical section to said second coordination system from said second housing position information stored in said second housing position information storing step on the basis of said first housing position information stored in said first housing position information storing step and said first optical position information stored in said first optical position information storing step;

30 an estimated location information producing step of producing estimated location information indicative of a position of said automotive vehicle to an image coordination system of said imaging device on the basis of said second optical position information produced in said second optical position information producing step;

a second optical position information storing step of storing said second optical position information produced in said second optical position information producing step;

35 an estimated location information storing step of storing said estimated location information produced in said estimated location information estimating step; and

a calibrating step of calibrating said second optical position information stored in

said second optical position information storing step on the basis of said image information of said automotive vehicle obtained by said imaging device and said estimated location information stored in said estimated location information storing step.

5 22. A camera calibrating method as set forth in any one of claims 17 to 21, in which said imaging device is mounted on an automotive vehicle.

23. A camera calibrating program of calibrating optical position information inductive of a position of an optical section supported by a housing unit of a camera for obtaining  
10 image information through said optical section, and allowing a computer to execute:

a first housing position information storing step of storing first housing position information indicative of a position of said housing unit in the first coordination system;

a second housing position information storing step of storing second housing position information indicative of a position of said housing unit in the second coordination  
15 system;

a first optical position information producing step of producing first optical position information indicative of a position of said optical section in said first coordination system on the basis of said image information obtained by said imaging device in said first coordination system;

20 a first optical position information storing step of storing said first optical position information produced in said first optical position information producing step;

a second optical position information producing step of producing second optical position information indicative of a position of said optical section to said second coordination system from said second housing position information stored in said second  
25 housing position information storing step on the basis of said first housing position information stored in said first housing position information storing step and said first optical position information stored in said first optical position information storing step;

a second optical position information storing step of storing said second optical position information produced in said second optical position information producing step;  
30 and

a calibrating step of calibrating said second optical position information stored in said second optical position information storing step on the basis of said image information obtained by said imaging device in said second coordination system.

35 24. A camera calibrating program of calibrating optical position information inductive of a position of an optical section supported by a housing unit of a camera for obtaining image information through said optical section, and allowing a computer to execute:

an optical position information storing step of storing optical position information indicative of a position of said optical section to a predetermined coordinate system; and

a calibrating step of calibrating said optical position information stored in said optical position information storing step on the basis of said image information obtained by said imaging device on said predetermined coordinate system.

25. A camera calibrating program of calibrating optical position information inductive of a position of an optical section supported by a housing unit of a camera for obtaining image information through said optical section, and allowing a computer to execute:

10 a first housing position information storing step of storing first housing position information indicative of a position of said housing unit in the first coordination system in which a revising marker is located;

a second housing position information storing step of storing second housing position information indicative of a position of said housing unit in the second coordination system in which a calibrating marker is located;

15 a first optical position information producing step of producing first optical position information indicative of a position of said optical section in said first coordination system on the basis of said image information of said revising marker obtained by said imaging device;

20 a first optical position information storing step of storing said first optical position information produced in said first optical position information producing step;

a second optical position information producing step of producing second optical position information indicative of a position of said optical section to said second coordination system from said second housing position information stored in said second housing position information storing step on the basis of said first housing position information stored in said first housing position information storing step and said first optical position information stored in said first optical position information storing step;

25 an estimated location information producing step of producing estimated location information indicative of a position of said calibrating marker to an image coordination system of said imaging device on the basis of said second optical position information produced in said second optical position information producing step;

30 a second optical position information storing step of storing said second optical position information produced in said second optical position information producing step;

35 an estimated location information storing step of storing said estimated location information produced in said estimated location information estimating step; and

a calibrating step of calibrating said second optical position information stored in said second optical position information storing step on the basis of said image information

of said calibrating marker obtained by said imaging device and said estimated location information stored in said estimated location information storing step.

26. A camera calibrating program of calibrating optical position information inductive of a position of an optical section supported by a housing unit of a camera for obtaining image information through said optical section, and allowing a computer to execute:

a first housing position information storing step of storing first housing position information indicative of a position of said housing unit in the first coordination system in which a revising marker is located;

a second housing position information storing step of storing second housing position information indicative of a position of said housing unit in the second coordination system;

a first optical position information producing step of producing first optical position information indicative of a position of said optical section in said first coordination system on the basis of said image information obtained by said imaging device and indicative of said revising marker;

a first optical position information storing step of storing said first optical position information produced in said first optical position information producing step;

a second optical position information producing step of producing second optical position information indicative of a position of said optical section to said second coordination system from said second housing position information stored in said second housing position information storing step on the basis of said first housing position information stored in said first housing position information storing step and said first optical position information stored in said first optical position information storing step;

a second optical position information storing step of storing said second optical position information produced in said second optical position information producing step; and

a calibrating step of calibrating said second optical position information stored in said second optical position information storing step on the basis of a motion vector of said image information obtained by said imaging device in said second coordination system.

27. A camera calibrating program of calibrating optical position information inductive of a position of an optical section supported by a housing unit of a camera for obtaining image information through said optical section, and allowing a computer to execute:

a first housing position information storing step of storing first housing position information indicative of a position of said housing unit in the first coordination system in which a revising marker is located;

a second housing position information storing step of storing second housing position information indicative of a position of said housing unit in the second coordination system in which an automotive vehicle is located;

5 a first optical position information producing step of producing first optical position information indicative of a position of said optical section in said first coordination system on the basis of said image information of said revising marker obtained by said imaging device;

a first optical position information storing step of storing said first optical position information produced in said first optical position information producing step;

10 a second optical position information producing step of producing second optical position information indicative of a position of said optical section to said second coordination system from said second housing position information stored in said second housing position information storing step on the basis of said first housing position information stored in said first housing position information storing step and said first  
15 optical position information stored in said first optical position information storing step;

an estimated location information producing step of producing estimated location information indicative of a position of said automotive vehicle to an image coordination system of said imaging device on the basis of said second optical position information produced in said second optical position information producing step;

20 a second optical position information storing step of storing said second optical position information produced in said second optical position information producing step;

an estimated location information storing step of storing said estimated location information produced in said estimated location information estimating step; and

25 a calibrating step of calibrating said second optical position information stored in said second optical position information storing step on the basis of said image information of said automotive vehicle obtained by said imaging device and said estimated location information stored in said estimated location information storing step.